

# 7 China



## 7.1 Summary of Coal Industry

### 7.1.1 ROLE OF COAL IN CHINA

Coal accounts for 69 percent of total national energy consumption in China (EIA, 2014a). Ranking first in the world in production of coal, China exported 16.5 million tonnes (Mmt) of coal in 2011; a sharp decline from a peak of 108.8 Mmt in 2003 (EIA, 2014b). Historically, a net coal exporter, China became a net coal importer in 2009 for the first time in more than two decades (EIA, 2014a). Table 7-1 provides recoverable reserve and recent coal production data for China.

**Table 7-1. China's Coal Reserves and Production**

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2011)	62,200	52,300	114,500	3 (12.9%)
Annual Coal Production (2012)	3,510.2	141.5	3,651.8	1 (46.3%)

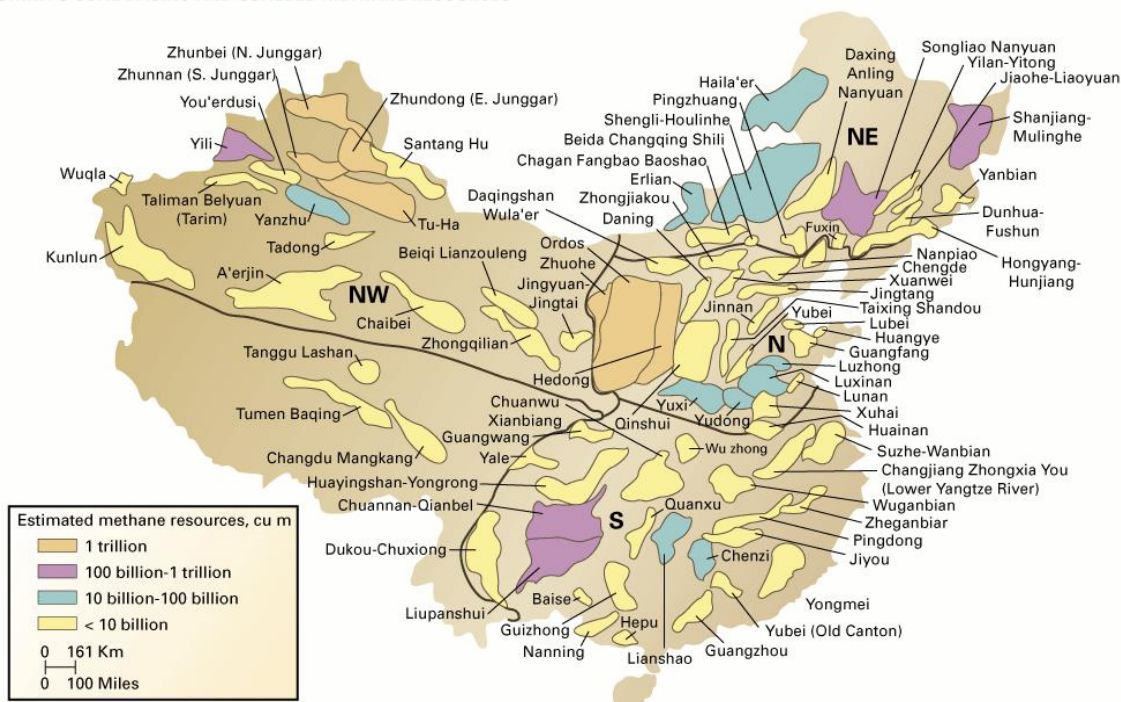
*Note: Numbers may not add due to rounding*  
Source: EIA (2014b)

As shown in Figure 7-1, the following major coal basins are located in four regions of China (USEPA, 1996):

- Sanjuang-Mulinghe, Songliao, Donhua-Fushun, and Hongyang-Hunjiang basins in the Northeast;
- Taixing-Shandou, Qinshui, Daning, Ordos, Hedong, Yuxi, Xuhuai, and Huainan basins in the North;
- Chuannon-Qianbei, Huayingshan-Yongrong, and Liapanshui basins in the South; and
- Tarim, Qaidam, and Junggar basins in the Northwest.

Figure 7-1. China's Coal Fields

CHINA'S COAL BASINS AND COALBED METHANE RESOURCES



Source: Liu (2006)

7.1.2 STAKEHOLDERS

Table 7-2 identifies some of the key stakeholders for coal mine methane (CMM) project development in China.

Table 7-2. Key Stakeholders in China's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining companies	<ul style="list-style-type: none"> <li>▪ Large coal groups, such as:</li> <li>▪ Chongqing Energy Investment Group</li> <li>▪ Datong Coal Group</li> <li>▪ Fushun Mining Group</li> <li>▪ Hebi Coal Industry Group</li> <li>▪ Henan Energy and Chemical Group</li> <li>▪ Huaibei Mining Group</li> <li>▪ Huainan Mining Group</li> <li>▪ Jincheng Anthracite Coal Group</li> <li>▪ Panjiang Coal &amp; Power Group</li> <li>▪ Shenhua Group</li> <li>▪ Shenhuo Group</li> <li>▪ Shuicheng Mining Group</li> <li>▪ Songzao Coal &amp; Power Group</li> <li>▪ Tiefa Mining Group</li> <li>▪ Xinji Group</li> </ul>	Project hosts

**Table 7-2. Key Stakeholders in China’s CMM Industry**

Stakeholder Category	Stakeholder	Role
Mining companies (con't)	<ul style="list-style-type: none"> <li>▪ Yangquan Coal Group</li> <li>▪ Zhengzhou Coal Group</li> </ul>	Project hosts
Equipment manufacturers	<ul style="list-style-type: none"> <li>▪ Atlas Copco</li> <li>▪ Capstone Turbine Corporation</li> <li>▪ Caterpillar</li> <li>▪ GE Jenbacher</li> <li>▪ Shengli Power Machinery</li> </ul>	Methane treatment and utilization equipment
Developers	<ul style="list-style-type: none"> <li>▪ China National Petroleum Corporation</li> <li>▪ China United Coalbed Methane Corporation Ltd.</li> <li>▪ CBM Exploitation and Development Company of the PetroChina Company Ltd.</li> <li>▪ Far East Energy</li> <li>▪ Lanyan CBM Company of the Jincheng Anthracite Coal Mining Group</li> <li>▪ Syndicatum Carbon Capital, SCC Americas</li> <li>▪ See also <a href="http://www.epa.gov/coalbed/networkcontacts.html">www.epa.gov/coalbed/networkcontacts.html</a></li> </ul>	Project opportunity identification and planning
Engineering, consultancy, and related services	<ul style="list-style-type: none"> <li>▪ China Coalbed Methane Clearinghouse, affiliated with the China Coal Information Institute</li> <li>▪ Guizhou International Cooperation Center for Environmental Protection</li> <li>▪ See also <a href="http://www.epa.gov/coalbed/networkcontacts.html">www.epa.gov/coalbed/networkcontacts.html</a></li> </ul>	Technical assistance
Universities, Research Establishments	<ul style="list-style-type: none"> <li>▪ China Coal Research Institute</li> <li>▪ China University of Mining and Technology</li> <li>▪ China University of Petroleum, Beijing</li> <li>▪ China National Administration of Coal Geology</li> <li>▪ China Coal Information Institute</li> </ul>	Technical assistance
Regulatory Agencies and Government Groups	<ul style="list-style-type: none"> <li>▪ National Development and Reform Commission</li> <li>▪ National Institute for Occupational Safety</li> <li>▪ State Administration of Coal Mine Safety, within State Administration of Work Safety</li> <li>▪ China National Coal Association</li> <li>▪ International Exchange Center of National Work Safety Administration</li> </ul>	Project identification and assessment support

Source: GMI (2005), Huang (2007)

### 7.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

China is the world’s leading producer of coal, producing almost 3.56 billion tonnes of coal in 2012 (Table 7-1). In 2013, production continued to rise at nearly a one percent increase on a year-on-year basis, with 3.68 billion tonnes (Huang, 2014).

Coal is produced throughout China in 28 provinces. Northern China, particularly Shanxi, Inner Mongolia, Shaanxi, and Xinjiang Provinces, contain most of China’s easily accessible coal and virtually all of the large state-owned mines (EIA, 2014a).

China has a large number of coal mines but has been attempting consolidation. It is estimated that in the mid-1990s, there were nearly 100,000 coal mines in China (IEA, 2009). The majority of these mines belonged to villages and towns. In the last decade, China has implemented programs to close down underperforming or unsafe mines, especially town and village coal mines. China’s State

Council has mandated the phasing out of mines producing less than 90,000 tonnes of coal per year. China's National Energy Administration (NEA) reports that 1,725 small-scale mines will be closed in 2014, with a total capacity of 117.48 Mmt (NEA, 2014).

As of 2014, there are approximately 12,000 coal mines operating in China (EIA, 2014a). Of these, 2,059 mines are owned by large, state-owned coal mine groups (known as "key coal mine groups"), accounting for 61.7 percent of total coal production. An additional 10,067 mines are operated by villages and towns (Guoquan, 2010). See Table 7-3 below.

Most coal mines in China are underground mines. As of 2012, underground mining accounted for 90 percent of Chinese coal production (Huang, 2013a).

**Table 7-3. China's Mines by Category and Percent of Total Production (2004)**

Mine Category	Number of Mines	Percent of Total Production
Local State-owned Key Coal Mine Groups	1,190	12
Other State-owned Key Coal Mine Groups	869	49.7
Mines Belonging to Villages and Towns	10,067	38.2

Source: Guoquan (2010)

## 7.2 Overview of CMM Emissions and Development Potential

Large, state-owned coal mines dominate Chinese coal production and CMM emissions. About 44 percent of large, state-owned mines are considered gassy (Huang, 2013a). Large, state-owned mines accounted for more than 86 percent of CMM emissions (2000), and produced 42 percent of total national coal production in 2004 (Zhang et al., 2004).

### 7.2.1 CMM EMISSIONS FROM OPERATING MINES

Increasing numbers of Chinese mines are installing drainage (degasification) systems. By 2006, more than 300 mines had installed CMM drainage systems (Huang, 2007) and as of 2011 this number had increased to 1,047 (Huang, 2013a). China's CMM drainage volume experienced a five-fold increase between 2005 and 2013, reaching 12.6 billion cubic meters (m<sup>3</sup>), up from 2.2 billion m<sup>3</sup> in 2005 (Huang, 2014). Approximately 80 percent of all CMM drained was from key, state-owned coal mines (Huang, 2007). The volume of CMM recovered and used in 2012 was 3.75 billion m<sup>3</sup>, more than six times 2005 levels (Huang, 2013a).

In 2011 China's mines emitted more than 19 billion m<sup>3</sup> of ventilation air methane (VAM), almost 8 billion m<sup>3</sup> of which was emitted from large, state-owned mines (Huang, 2013a).

Table 7-4 shows historical data (where available) for CMM emissions, drainage, and utilization levels in China.

**Table 7-4. China's CMM Emissions (million cubic meters)**

Year	CMM Emissions	CMM Drainage	CMM Utilized
2000	9,435*	870	318.4
2005	18,005*	2,300†	900†
2010	20,694*	7,500**	2,500††
2011		9,200**	3,500^
2012		11,400**	3,500^^
2013		12,600‡	4,250‡
2015(projected)	22,490*		

Sources: GMI (2005); \*USEPA (2012a); \*\*Huang (2013a); †Huang (2007); ††CCII (2011); ^Huang & Liu (2012); ^^Huang (2013b); ‡Huang (2014)

In China, the main types of CMM use projects are town gas, electricity generation, industrial boiler fuel feed, vehicle fuel, and thermal applications (e.g., office space heating). Some Chinese CMM projects involve multiple end uses. As of 2013, China's CMM use projects utilized 4.25 billion m<sup>3</sup> of methane (Huang, 2014). CMM-to-power projects generated a total of more than 1,500 MW of power by the end of 2011 (Huang, 2013a). Additionally, approximately 4,000 vehicles operate on CMM as fuel (Huang, 2010).

As technology has advanced, the utilization efficiencies of CMM projects have also improved, increasing the size of individual projects (Huang, 2007).

The largest CMM power project in the world is located at the Sihe Mine in Jincheng, Shanxi Province. This project uses Caterpillar engines to generate electricity at a 120-MW capacity power plant. The project utilizes more than 187 million m<sup>3</sup> of both coal bed methane (CBM) and CMM from the Sihe mine (USEPA, 2006; Huang, 2008; Huang, 2013a; Sun, 2014). The Sihe project avoids the release of more than 3 million metric tons of carbon dioxide equivalent (MMTCO<sub>2</sub>E) annually (Sun, 2014).

Use of CMM resources is being expanded for application in the chemical industry in China. For example, formaldehyde and carbon black are being produced using CMM in Fushun, Huainan, Zhongliangshan, Songzao, and Tianfu.

Information on individual CBM/CMM use projects in China can be found in the Global Methane Initiative (GMI) International CMM Projects Database, which includes information on more than 350 current and planned CMM projects around the world (GMI, 2014). The database includes 67 active CMM projects in China, all at active underground mines. Of these projects, seven use CMM as boiler fuel; four provide methane for industrial use; 29 use CMM for power generation; 14 provide town gas; two provide vehicle fuel; and three are VAM mitigation projects (GMI, 2014).

China is host to the first VAM project approved by the UNFCCC. The VAM abatement and energy recovery project was commissioned in October of 2008 in Zhengzhou and provides hot water for local use (Mattus, 2012). Annual emission reductions average 382 thousand MTCO<sub>2</sub>E (UNFCCC, 2008). Additionally, at the Datong mine in Chongqing Municipality, hosts the largest VAM abatement system in the world, operating since mid-2011. This project, which includes hot water for local use, reduces greenhouse gas (GHG) emissions by approximately 184 MTCO<sub>2</sub>E per year (Mattus, 2012; UNEP, 2014).

Chongqing Energy Investment Group Corporation, Chongqing Songzao Coal and Electricity Co., Ltd. and DKT Technology, signed a joint venture for construction and operation of a CMM project at the Songzao coal mines. This project is a result of a feasibility study funded by the U.S. Environmental Protection Agency (U.S. EPA). DKT will construct a CMM to liquefied natural gas (LNG) plant that will connect to Songzao's gas pipeline network. The plant will use CMM with a concentration of 30 percent methane in air as feed gas. The plant capacity is designed to process 15,000 standard m<sup>3</sup> of CMM per hour yielding 35 million m<sup>3</sup> of methane per year. Due to expected fluctuations of CMM flow and concentration, production will vary from 30 to 40 million m<sup>3</sup> (25,000 - 30,000 tonnes) of LNG per annum (DKT, 2015).

### 7.2.2 CMM EMISSIONS FROM ABANDONED COAL MINES

The China Coal Information Institute (CCII) established the Abandoned Mine Methane Project Advice Centre (AMMPAC) to advise and promote the country's abandoned mine methane (AMM) use (CCII, 2010). Initially funded by the UK Foreign and Commonwealth Office through its Climate Change Challenge Fund, the program was designed to help build capacity for CCII to provide guidance and disseminate training to mining enterprises and project developers, through activities ranging from assistance evaluating and developing AMM schemes to technical guidance documents to assistance finding potential investors and technical specialists (Creedy et al., 2010). Further information about this program is available at <http://www.coalinfo.net.cn/cnuk/eprojects/05.htm>. Additionally, GMI funded a cooperative agreement to investigate abandoned mine methane emissions in China entitled, "Methane Emissions from Abandoned Coal Mines in China." Information about this project and results of analysis can be found at [www.chinamethane.org](http://www.chinamethane.org).

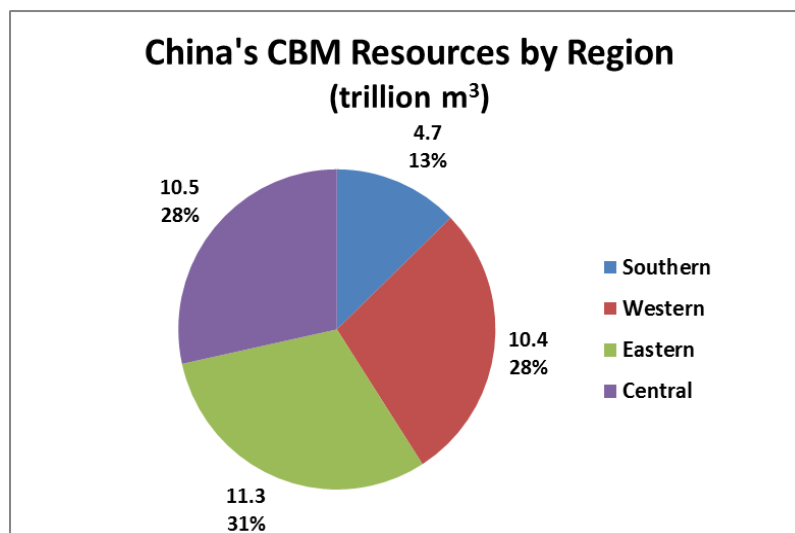
The closing of state-owned coal mines and town and village coal mines that do not meet production and safety requirements has left a large number of abandoned mines throughout China. Hundreds of coal mines have been abandoned since the 1950s and abandoned reserves are estimated at more than 30 billion tonnes. To date, no AMM projects have been initiated in China.

CCII's Xi'an branch has also studied AMM resources in China, focusing on detailed geological conditions, characteristics of AMM reservoirs, gob/goaf area and coal reserve estimation, ground water study and mine gas sampling, and AMM resource estimation (CCBMC, 2004).

### 7.2.3 CBM FROM VIRGIN COAL SEAMS

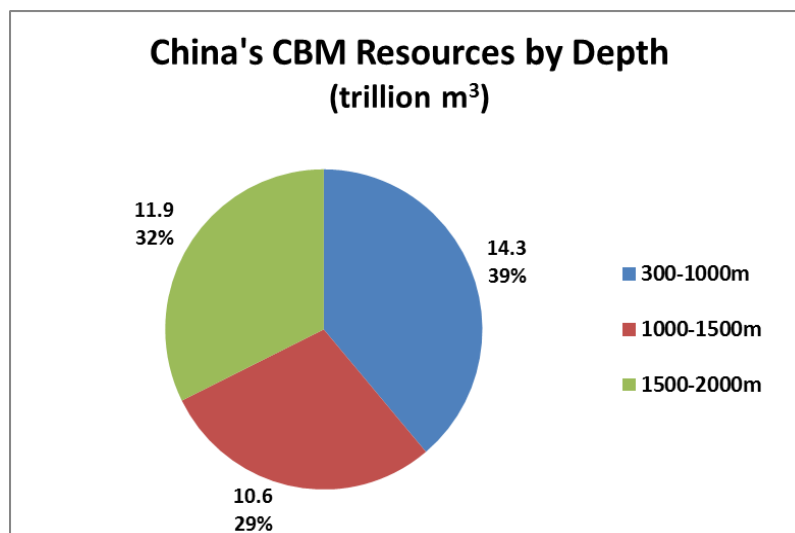
China's CBM resources contained in bituminous and anthracite coal deposits at depths between 300 and 2000 meters are estimated to be 36.8 trillion m<sup>3</sup> (Huang, 2010; Huang, 2013a). Figures 7-2 and 7-3 display China's distribution of CBM resources by region and depth.

Figure 7-2. China's CBM Resources by Region



Source: Huang (2013a)

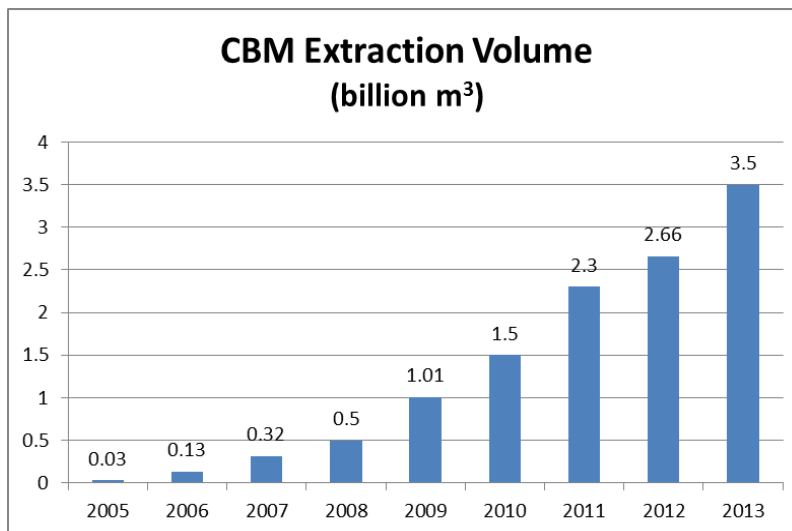
Figure 7-3. China's CBM Resources by Depth



Source: Huang (2013a)

The total production of CBM has increased dramatically within the last decade as shown by Figure 7-4. Total Chinese CBM production was estimated to be 3.5 billion m<sup>3</sup> in 2013. The national production target for CBM is 10 billion m<sup>3</sup> by 2010 (Huang, 2007; EIA (2009); Merrill, 2007).

**Figure 7-4. China's Annual CBM Production**



Source: Huang (2013a)

By the end of 2012, a total of 12,547 CBM wells had been drilled in China. Of these, 4,420 wells have been drilled by the Jincheng Anthracite Mining Group (JAMG). JAMG had 2,650 wells in production in 2012, producing 3.9 million m<sup>3</sup> per day for an annual total of 713 million m<sup>3</sup> (Huang, 2013a).

Between 2011 and 2015, China National Petroleum Corp. (CNPC), China's largest oil and gas producer, is investing \$1.14 billion in drilling 371 horizontal wells in the Zhengzhuang, Qinnan, Mabi, and Xiadian blocks of the Qinshui Basin in Shanxi Province to increase annual production capacity (China Coal Resource, 2010; CNPC, 2013). In 2011, CNPC enhanced CBM production capacity in the Qinshui Basin and expanded into the eastern edge of the Ordos Basin, supplying 420 million m<sup>3</sup> of commercial CBM. In 2012, CNPC proved 78.8 billion m<sup>3</sup> of CBM in place, built an additional 1.35 billion m<sup>3</sup> of production capacity, and supplied 600 million m<sup>3</sup> of commercial CBM (CNPC, 2013).

### 7.3 Opportunities and Challenges to Greater CMM Recovery and Use

China is a signatory to both the UNFCCC and the Kyoto Protocol (Table 7-5). As a Non-Annex I Party to the Kyoto Protocol, China was eligible to host GHG mitigation projects, such as CMM projects, under the Clean Development Mechanism (CDM). The CDM created additional revenues for CMM projects in China through carbon credits trading. As of 2014 China had 3,750 registered CDM projects. Of these, 83 are CMM projects (UNEP, 2014).



**Table 7-5. China's Climate Change Mitigation Commitment**

Agreement	Signature	Ratification
UNFCCC	June 11, 1992	January 5, 1993
Kyoto Protocol	May 29, 1998	August 30, 2002

Source: UNFCCC (2014)

Though China has no emissions targets under the UNFCCC or Kyoto Protocol, China's government announced in November of 2009 that it would cut emissions of carbon relative to economic growth by 40 percent to 45 percent by 2020 compared with 2005 levels (Huang and Wu, 2010). In 2010, the Chinese government announced its Twelfth Five-year Plan, which required the development of an emissions trading scheme (ETS) in China. In 2011, the National Development and Reform Commission (NDRC) General Office published the "Notice on Carbon Emissions Trading Pilot," in which Beijing, Tianjin, Shanghai, Chongqing, Guangdong, Hubei and Shenzhen, in total, seven provinces and cities were assigned as ETS pilots in China. As of early 2014, programs have been initiated in six of these regions as shown in Table 7-6 (Environomist, 2014). These pilot programs are expected to serve as testing ground for a national ETS to be implemented after 2016 (Carbon Market Watch, 2013).

**Table 7-6. China’s Regional Pilot Emissions Trading Schemes**

	Guangdong	Hubei	Shanghai	Tianjin	Shenzhen	Beijing	Chongqing
<b>2015 Emission Reduction Target (compared to 2010)</b>	19.5%	17%	19%	15%	15%	18%	17%
<b>Reporting Obligations</b>	Industrial companies emitting more than 10,000 tons of CO <sub>2</sub>	Companies consuming more than 8,000 tons of standard coal per year	Companies emitting more than 10,000 tons of CO <sub>2</sub> per year	Carbon-intensive industries such as iron and steel, chemical, power, heating, petrochemical and exploitation and those of civil buildings, which emit more than 10,000 tons of CO <sub>2</sub> annually	Companies emitting more than 3,000 but less than 5,000 tons of CO <sub>2</sub> annually, and other enterprises and buildings in specific area	Companies consuming more than 2,000 tons of standard coal per year in the provincial area	Pending
<b>Compliance Coverage</b>	Companies emitting more than 20,000 tons of CO <sub>2</sub> in industries of power, cement, iron and steel, ceramic, petrochemical, textile, non-ferrous metals, plastics, and paper	Industrial companies consuming more than 60,000 tons of standard coal annually	Carbon-intensive industries such as iron and steel, which emit more than 20,000 tons of CO <sub>2</sub> annually; non-industrial enterprises which emit more than 10,000 tons of CO <sub>2</sub> annually	Carbon-intensive industries such as iron and steel, which emit more than 20,000 tons of CO <sub>2</sub> annually	Enterprises and institutional organizations which emit more than 5,000 tons of CO <sub>2</sub> per year, large public buildings over 20,000 square meters, office buildings for governmental agencies over 10,000 square meters	Companies emitting more than 10,000 tons of CO <sub>2</sub> annually, both direct and indirect	Pending
<b>Commenced</b>	December 2013	December 2013	November 2013	December 2013	June 2013	November 2013	Pending

Source: Environomist (2014)

### 7.3.1 MARKET AND INFRASTRUCTURE FACTORS

Coal provides 69 percent of the energy consumed annually in China, with only four percent provided by natural gas. The NEA's Twelfth Five-year Natural Gas Development Plan called for the natural gas percentage to reach about eight percent by year-end 2015, and it is commonly projected that the percentage will exceed 10 percent by 2020 (EIA, 2014a; USEPA, 2012b).

Methane that occurs in coal has gradually evolved from a pure mine safety concern to a valued commodity and a significant component of the natural gas resources that the government plans to develop under its Twelfth Five-year Plan. The Twelfth Five-year Natural Gas Development Plan explicitly includes CBM for the first time, targeting consumption to rise to 20 billion m<sup>3</sup> by 2015, or about eight percent of the total. The NEA's Twelfth Five-year Plan for CBM and CMM is even more ambitious, calling for total production to rise to 30 billion m<sup>3</sup> by 2015 – 16 billion for CBM and 14 billion for CMM. The utilization rate for pumped CMM is called to rise to 8.4 billion m<sup>3</sup> from the 2010 level (NEA, 2011).

Of the 16 billion m<sup>3</sup> of CBM captured through surface drilling, the NEA projects that 10 billion should come from the Qinshui Basin, 5.4 billion from Ordos Basin, with the remaining 600 million coming from smaller developments in 1) the Tiefu and Fuxin areas of Liaoning Province, 2) from “experimental” programs in the Jiaozuo and Pingdingshan areas of Henan Province, 3) the Anshun and Zhijin areas of Guizhou Province, and 4) other areas in Xinjiang, Anhui, Sichuan, and Gansu Provinces, where drilling conditions are more challenging. Significantly, the plan also calls for the construction of 13 pipelines with total length of more than 2,000 kilometers and 12 billion m<sup>3</sup> per year total transport capacity, signaling a significantly stepped-up effort to integrate CBM into the largest natural gas economy. These efforts were already underway in the latter part of the 2000s, with the construction by CNPC of a one billion cubic meter per year CBM processing facility in the Qinshui basin with the intent to inject its own and third-party CBM into the nearby first West to East pipeline.

The NEA's Twelfth Five-year Plan for Development of CBM/CMM calls for CMM to be used primarily as a local fuel, with the number of residential users to approximately double to about 3.3 million households between 2010 and 2015, and power generation capacity to quadruple to 2850 MW as overall CMM utilization rises by about 5.5 billion m<sup>3</sup>. The Plan also calls for CMM power generation capacity to quadruple to 2,850 MW between 2010 and 2015, and reiterates that, while the power should be consumed by the mines themselves when possible, the policies regarding off-take by the grid should be implemented. Given the limited ability of the mines to absorb all of the power, the fulfillment of the Twelfth Five-year Plan targets will depend on more rigorous adherence by the grid to the off-take policies (NEA, 2011).

The focus on local consumption of CMM poses challenges, as many of the coal mines recovering CMM have exhausted the possibilities for burning the CMM to generate power for their own use, or supplying CMM to customers in the immediate vicinity of the mines. Additionally, given the rapid construction of electricity generation capacity in China since 2003, including many projects still outstanding, there is a distinct possibility that power generation capacity will outstrip demand in many parts of the country through 2015-2017.

Only a few local governments such as Jincheng, a municipality of approximately two million people in the Qinshui basin area, have mobilized to invest in region-wide CMM distribution infrastructure. Jincheng has advantages that other localities do not necessarily share, including the ability to mix

higher methane-content CBM with its CMM, and a supportive provincial government, which has granted CMM producers an additional 0.3 yuan per cubic meter rebate for CMM sales for civil and industrial use on top of the 0.2 yuan offered by the national government. Despite the booming demand for natural gas, municipalities such as Chongqing have not found it cost-effective to construct the medium-distance pipelines necessary to transport unprocessed CMM from large producers such as Songzao into the city proper in view of the gathering, pipeline investment, and processing costs.

The government's Twelfth Five-year Plan for CBM and CMM addresses the barriers to the further popularization of CMM in general terms, acknowledging the unfavorable economics of many CMM utilization projects, the difficulties winning power grid company acceptance of the existing regulations requiring them to accept CMM-generated power at premium prices, and the need for stronger government incentives to promote CMM utilization. Follow-through on removal of these barriers will be vital to enforcing the power dispatch and CMM pricing policies and achieve the power generation targets.

As with CBM, the purification and liquefaction of CMM offers a potential solution to the market barrier problems. Technologies to remove impurities of CMM at low temperature have been proven outside of China, and are under development in China itself; no extra step is required to liquefy once purification has taken place. While it would most likely not be economic to sell the product to the petroleum pipeline companies given the domestic gas pipeline transmission pricing structure, transportation by tanker truck would allow the CMM plants to sell directly to near or distant distribution companies. In general, the economics of purified and liquefied CMM should be attractive under conditions where overall supply continues to be tight, and imported gas is a significant component of the overall natural gas sales base.

While many coal mining companies have considered the LNG option for utilization of their CMM, most have hesitated to move ahead in view of the high up-front cost relative to other options such as small distributed power plants, and the lack of reference CMM to LNG units in China. As of mid-2012, only small demonstration facilities constructed by Chinese purification technology developers were in operation.

The number of mines with degasification systems in China has more than tripled since 2006; however, still relatively few of China's underground mines have installed degasification systems. Even where degasification systems have been installed, they have encountered challenging geologic conditions for which degasification technologies commonly used in China are often unsuitable (Huang, 2005; Huang, 2013a). Even where there are drainage systems in place, there are still a number of challenges to effectively recovering and using the methane from mine drainage systems. These barriers include small project size, fluctuating methane production, the high capital cost of utilization projects, and limited infrastructure.

Currently, with China's underdeveloped natural gas market, many do not have access to natural gas, limiting the potential market for CMM. Of the estimated 664 million people living in Chinese cities, suburbs, and towns, only 145 million had access to natural gas at year-end 2010. Entire provinces, such as Guizhou, Yunnan, Guangxi, and Ningxia offered virtually no gas to their urban residents, and even highly-developed provinces such as Guangdong and Jiangsu only offered gas to 12 and 22 percent of their respective city and town dwellers. As for CMM, most of the mines in China are located in remote mountain areas, where the terrain makes it difficult to construct long-distance pipelines to deliver drained CMM to cities. The first West-East Natural Gas Pipeline, between

Xinjiang and Shanghai, began operating in October 2004, and has a capacity of 17 billion m<sup>3</sup> of natural gas, which is supplied to 10 provinces across China's Eastern and Western regions. However, only a few coal mining areas are close enough to the pipeline to have the possibility of accessing it for delivery of CMM. The second West-East Pipeline commenced operation and connects Xinjiang to Guangdong with a capacity of 30 billion m<sup>3</sup>.

The price structure in China has historically favored use of CMM over natural gas, with the consumer price of CMM for civil and industrial consumption set far lower than that of natural gas (GMI, 2005). In April 2007, the Ministry of Finance provided a subsidy of 0.2 Yuan/m<sup>3</sup> for CMM utilization; the local finance departments are allowed discretion to increase their own subsidies based on this standard (Huang 2007; Guizhou, 2008; Huang, 2012). The government also provides a 0.25 yuan/kilowatt-hour subsidy for CBM/CMM-fueled power generation, which is the same subsidy offered for biomass power generation. Since 2007, the central government has awarded subsidies of 1.8 billion yuan to support CBM/CMM development, which accounted for 9.2 billion m<sup>3</sup> (Huang, 2012).

Large-scale development of shale gas could lower the cost structure of the national gas industry as it has in the United States, also working against the interests of CMM producers. Given the time that will be required to develop shale gas expertise, this is likely to be a long-term rather than a medium-term issue.

Many organizations in China and abroad have financially sponsored the research and development of CMM projects (GMI, 2005). They include the China Coalbed Methane Clearinghouse of CCII, National Development and Reform Commission (NDRC), State Administration of Coal Mine Safety (SAWS), U.S. Trade and Development Agency, World Bank, Asian Development Bank (ADB), Global Environment Fund, Clean Development Mechanism, and Japan Development Fund.

A detailed discussion of China's market for CMM may be found in the United States Environmental Protection Agency document *China's Energy Markets: Anhui, Chongqing, Henan, Inner Mongolia, and Guizhou Provinces*, at <http://epa.gov/cmop/docs/2012ChinaEnergyMarket.pdf>.

### 7.3.2 REGULATORY INFORMATION

In China, recovery and utilization of CMM can only be exercised by coal enterprises with legal mining licenses. CMM projects require approval from the NDRC at the county, provincial, and central government level, depending on the size and type of project. CMM power generation projects that are connected to the power grid must be approved by the investment administration of the provincial government. CMM projects generating power used only by the mining company must be recorded by the investment administration of the local government. The investment administration of provincial governments shall report both approved and recorded projects to the investment administration of the State Council (NDRC, 2007).

A CBM or CMM pipeline project with the capacity to transport more than 500 million m<sup>3</sup> a year or crossing provincial borders shall be approved by the investment administration of the State Council. A CBM or CMM pipeline project with capacity to transport less than 500 million m<sup>3</sup> a year shall be approved by the investment administration of the provincial government (GOSC, 2006).

China has established a number of financial incentives to encourage CMM projects. Developers are exempt from the prospecting and licensing fees on CBM development, and no royalties are levied on

CBM through 2020. Value added tax (VAT) collected from coal mines recovering and utilizing CBM/CMM is returned to the coal mining companies, and no income tax is paid by enterprises developing technologies for CMM recovery and utilization. Coal mine owners or developers investing capital in CMM projects through loans or self-equity financing can claim 40 percent of the capital value to offset income taxes (Huang, 2012; IEA, 2009).

These policies have the potential to encourage CMM project development; however, it is notable that in order to obtain the aforementioned subsidies and tax exemptions, a developer must request them at the appropriate level as well as follow up on a regular basis.

Additionally, China's Central Government provides 3 billion CNY for coal mine safety projects each year, most of which is used for mine gas recovery projects. Coal mines can collect 15-20 CNY per ton from coal sales to be applied to mine safety projects (Huang and Wu, 2010).

All exploration and mining activities must be approved by the Ministry of Land and Resources (MLR) or with provincial land and resources bureaus (LRBs) to obtain exploration or mining rights. Large coal mines in excess of 100 million metric tons of reserves must obtain licenses through the MLR; however, smaller mines may obtain permission from provincial LRBs as a result of government restructuring in the late 1970s. Oil and gas activity must be registered through the MLR as the central government did not transfer management power to local levels as it did in the coal industry. China's Mineral Resources Law was passed in 1986 and did not list CBM independently as a mineral resource until it was amended in 1996, clarifying that CBM is one of China's 34 mineral resources, amongst other issues.

The rights to exploration and development of CMM or CBM projects in China have been modified to be more inclusive. Initially, the China United Coalbed Methane Corporation (CUCBM) had the monopoly rights to CMM or CBM exploration, development, and production in cooperation with foreign firms. If a commercial CBM field was found, CUCBM and the foreign party would jointly establish an organization and conduct development and production. However, on September 24, 2007, the State Council modified the relevant regulations, "Regulations of the People's Republic of China on Exploitation of On-shore Petroleum Resources in Cooperation with Foreign Countries," to effectively eliminate the CUCBM monopoly. The law now includes the option for "other companies designated by the State Council" to join with foreign businesses in exploiting CMM resources (Huang, 2007). Alternatively, if a CMM development project is to be realized by foreign grants or free technical assistance (i.e., if the projects are non-profit and non-commercial in nature), it is not necessary to involve CUCBM (CBMC, 2004).

Exploration and mining of CBM is registered in the same manner as conventional oil and gas, and since 1998 three centrally-controlled state-owned enterprises (SOEs), CUCBM, CNPC, and China Petroleum and Chemical Corporation registered for exploration rights of approximately 65,000 m<sup>2</sup> of CBM blocks, comprising more than half of the total CBM blocks, while other SOEs such as China Petro-Chemical Corporation (SinoPec) registered for smaller shares (Lin, 2011).

All CMM projects must conform to relevant environmental and safety regulations before operating. Projects should focus on waste water drainage, atmospheric pollution, and noise pollution. Energy use during the projects should be in accordance with the "Energy Conservation Law of the People's Republic of China" and the energy-saving regulations and measures of the state and local governments. The State Administration of Work Safety (SAWS) monitors worker safety in China.

Laws and regulations such as the “Coal Mine Safety Regulation” should be followed when developing CMM exploitation and utilization projects.

China’s Ministry of Environmental Protection issued an Emission Standard of CBM/CMM in 2008 for new coal mines and drainage systems. The standard requires operators of CMM drainage systems with greater than 30 percent methane concentration to use or flare the gas. As of 2012, anecdotal evidence indicated this policy was creating a perverse incentive in some areas to maintain gas concentrations below 30 percent by dilution, ignoring best practices and safety standards (USEPA, 2012b).

For a detailed discussion of ownership and policy issues related to CBM and CMM in China and worldwide, see the United States Environmental Protection Agency document *Legal and Regulatory Status of CMM Ownership in Key Countries: Considerations for Decision Makers*, at <http://www.epa.gov/cmop/docs/CMM-Ownership-Policy-White-Paper-July2014.pdf>.

## 7.4 Profiles of Individual Mines

Feasibility studies for CMM projects at a few Chinese mines, profiles of some individual mines in China, and descriptions of CMM project opportunities are available on the following web sites:

- Global Methane Initiative (GMI): <http://www.globalmethane.org>
- U.S. EPA: <http://epa.gov/cmop/international/china.html>
- China Coal Information Institute (CCII): <http://www.nios.com.cn/cbmproject.html>

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